Spatial distribution of beef cattle on a New Zealand hill country farm: monitoring the use of streams and wet areas

Ina Draganova[1], Amy Hoogenboom[2], Lucy Burkitt[3], Rebecca Hickson[2], Mike Bretherton[3], Carolyn Hedley[4], Pierre Roudier[4], Stephen Morris[2]

1New Zealand Centre for Precision Agriculture, Massey University, Palmerston North.

2Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North.

3Fertilizer and Lime Research Centre, Massey University, Palmerston North.

4Landcare Research, Palmerston North.

Email: I.Draganova@massey.ac.nz

Abstract

Grazing livestock are an important source of contamination of freshwater, particularly when they have direct access to streams. Cattle in particular contribute to riparian habitat deterioration through stream bank destruction and direct defecation and urination in streams. Exclusion of stock or planting of riparian areas, are the most common catchment management methods used to protect waterways. Given the relatively low returns from beef and sheep farming, both of these strategies are very expensive and often logistically prohibitive in steep hill county landscapes. Despite this, policy trends indicate that fencing of streams in agricultural catchments may become mandatory in the future. It is important that we understand how much time cattle spend in and around hill country streams and wet areas (wetlands and hill side seeps), in order to quantify the likely environmental benefits from such policies.

The current study examined cattle movement data obtained using Global Positioning System (GPS) collars from experiments undertaken at Massey University's hill country research farm, Tuapaka, near Palmerston North, to investigate the amount of time cattle spent in and around streams and wet areas. Animal movement data were collected over seven grazing events, in three winter periods (2012, 2013 and 2015). Permanent streams and wet areas were identified using a digital elevation model derived from 1m LiDAR data, aerial RGB images and RTK measurements.

Cattle spent 3.3 – 6% (48 – 86 min/day) of their day in streams and wet areas consistently across the 7 data collections. Cattle spent more time in streams and wet areas during the afternoon. There are differences in the median amount of time individual animals spend in non-risk areas. Further research is necessary to evaluate how we can influence the amount of time cattle spend in riparian areas on hill country and how stream bank behaviour varies at different times of the year.

Introduction

New Zealand agricultural land has been intensified over recent decades, and there has been a corresponding decline in water quality, particularly through increases in nitrogen, phosphorus and sediment contamination of waterways. Cattle with unrestricted access to streams are most often associated with defecation and urination into the waterway, as well as destruction of the riparian vegetative cover, bank erosion and changes in soil properties (Osmond et al., 2007, Franklin et al. 2014). The contaminants most commonly associated with cattle grazing are nutrient, bacteria and sediment (Osmond et al. 2007, Franklin et al. 2014). Of these faecal coliform bacteria and sediment have been identified as the more problematic contaminants (Osmond et al. 2007).

Exclusion fencing of riparian areas and waterways is widely regarded as the best management option (Osmond et al. 2007), the other preferred method for protection of waterways in New Zealand is riparian planting (McKergow et al. 2016). The Ministry for Environment (2016) indicates livestock exclusion on hill country pastures may become mandatory by 2025. However, the low returns from sheep and beef farming, the large number of water courses and wet areas which intersperse hill country farms and the need for stock to access water and traverse farms means that these strategies are not financially or practically feasible on many farms.

The primary aim of this study was to investigate the amounts of time cattle spend in streams and wet areas on hill country pastures. The study also examined how time spent in streams and wet areas varied with time of day and between different animals.

Materials and Methods

Four paddocks (Table 1) were selected on Massey University's hill country research farm, Tuapaka, north-east of Palmerston North. Animal movement data was recorded from 47 randomly selected mixed-age beef cows fitted with GPS collars. All animals were Angus, Angus-cross-Friesian or Angus-cross-Jersey. Data was collected from June to August, for seven grazing events, during 2012, 2013 and 2015.

Table 1. Area and animals used in the experiments for 2012, 2013 and 2015. Numbers in brackets represent individual grazing events in the descending order.

	Paddock 9	Paddock 10	Paddock 11	Paddock 12
Area (ha)	12.8	8.8	8.04	5.0
Maximum Slope (°)	62	52	50	49
Animals (n)(event)				
2012			11 (1)	
2013		13 (2)	10 (3)	
2015a	8 (4)			7 (6)
2015b	7 (5)			8 (7)

GPS Collars

Individual animals were fitted with a neck collar mounted with a Global Positioning System (GPS) unit for a 6-day experimental period in each grazing event. The GPS units were custom-made using Trimble® Lassen modules (Draganova 2012) programmed to run continuously, logging position whenever a cow moved ≥4 m or every 1 minute if the cow did not move during that time. The standard deviation of points was 1.2m (range 0.0-15.2m).

Mapping of streams and wet areas

Permanent streams and wet areas were identified using a RGB image and a digital elevation model derived from 1m LiDAR data and Real Time Kinematic (RTK) GPS ground points taken on farm. Paddock twelve, for data collection events 6 and 7 had no wet areas within the paddock.

Definitions

Streams – permanent flowing of water. Ephemeral streams were excluded from this study.

Wet area – naturally occurring wetlands and areas where water seeps out of the side of a hill and creates a wet area.

Non-risk – all other areas within the paddock that have not been classed as a stream or wet area.

Data Processing and Analysis

GPS point data were used to investigate the spatial preference of animals for locations within each paddock. A five-meter buffer was created around each stream and wet area using data management functions (ArcGIS Pro 1.4, Esri, Redlands, CA, USA). The 5m buffer was applied to account for the level of precision associated with GPS collars. Statistical analysis was conducted using SAS (v9.3, SAS Institute Inc., Cary, NC, USA). Proportion of time spent in 'stream', 'wet area' and 'non-risk' were fixed for effect of cow, hour and event.

Results

Grazing events

The percentage of time spent in streams, wet areas and non-risk areas over a 24hr period varied between the seven grazing events. However, cattle spent the largest percentage of their day in non-risk areas of the paddock (Fig 1). Cattle in event 5 spent the least amount of time in streams and wet areas, while the cattle in event 2 spent the most time, spending almost 1.5 hr/day in streams and wet areas combined (Table 2). The mean amount of time spent in streams across all 7 events was 67.5min/day.

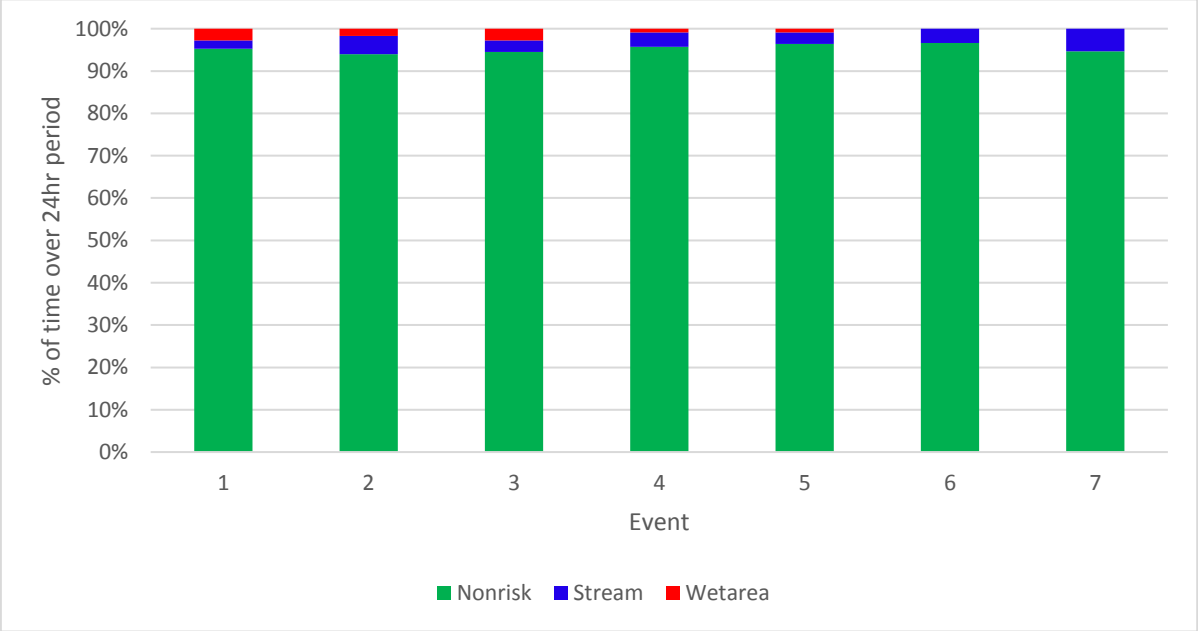

Figure 1. Mean percentage of time spent in non-risk, stream and wet areas over a 24hr period for each data collection event

Table 1. Mean number of minutes per day cattle spent in streams and wet areas combined for each data collection event.

Event	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7
Mean minutes/day	68	87	79	62	52	49	76

Time of day

Cattle spent more time in streams and wet areas between 1pm and 6pm than any other time of day, with a peak time between 3pm and 5pm (Fig. 2).

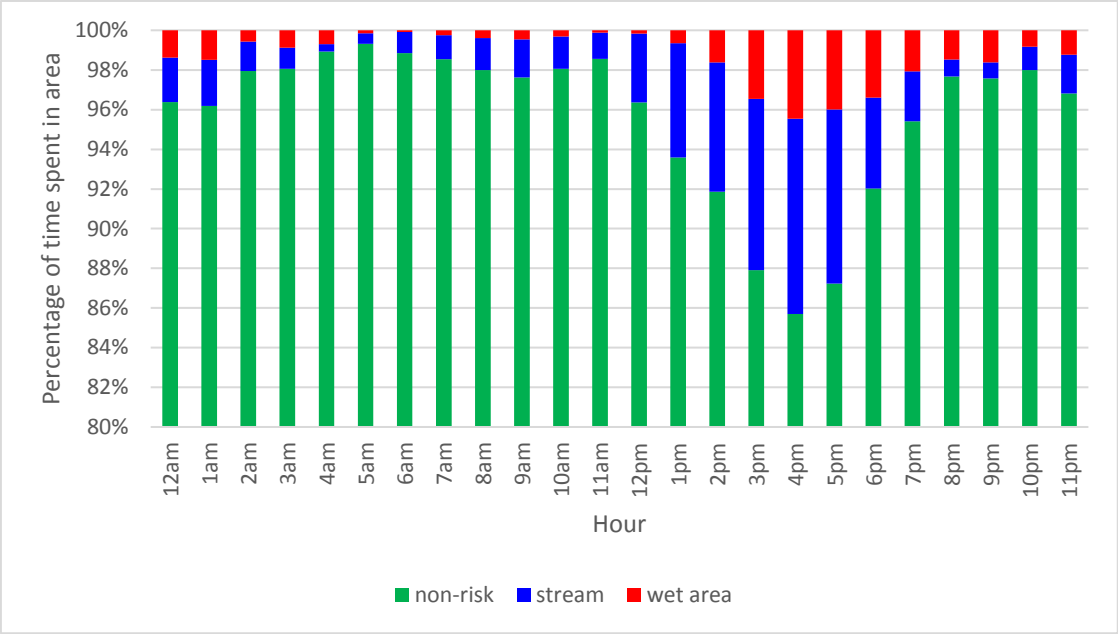

Figure 2. Mean percentage of hour spent in different areas progressing over the course of 1 day averaged across the 7 events

Individual animals

The amount of time individual cattle spent in non-risk areas varied, with one cow spending 100% of her time in non-risk areas. In contrast another cow spent 88.8% of her time in non-risk areas (Fig 3). Of the 47 cows, 35 cows spent over 94% of their time in non-risk areas.

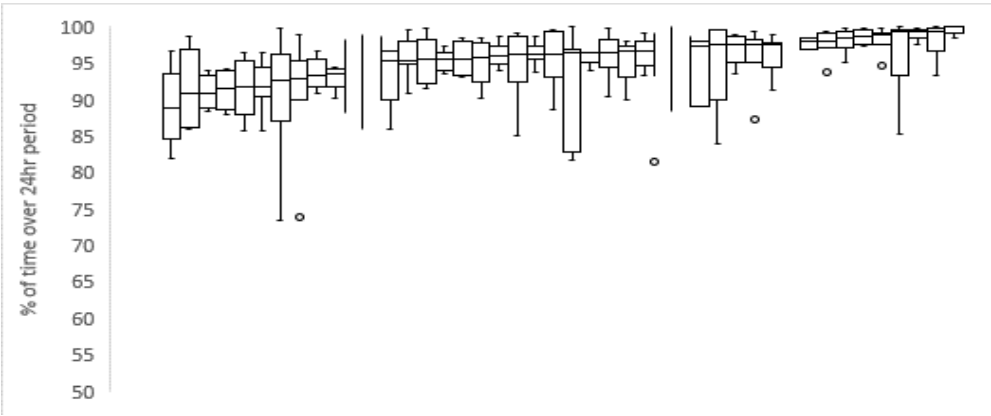

Figure 3. Percentage of time spent in non-risk area for individual cows. Each boxplot represent data for individual cows in the study.

Discussion

Cattle spent 67.5 min/day in streams and wet areas. A study reviewed by Osmond et al. (2007) estimated cattle spent an average of 6 min/day in the stream, while other studies recorded cattle spending 25 min/day and 60 min/day in the streams (Bond et al. 2012, Franklin et al. 2014). It is possible these differences are due to physical characteristics of terrain and study design. Most reviewed studies looking at cattle behaviour in regard to riparian zones are carried out on relatively flat terrain and in areas where there were only one or two water access points. This study was conducted on medium to steep hill country with multiple streams and wet areas within the paddocks, providing much more opportunity for cattle to enter these areas. Furthermore, data to date is based on observational records over shorter periods of time, while this study used tracking technology over longer time period to account for variability over time.

The observation of increased time spent in streams and wet areas during the afternoon is consistent with existing literature (Bond et al. 2012; Franklin et al. 2014 and Osmond et al. 2007) and may reflect the pattern in daily temperatures, with cattle spending more time in riparian areas when temperatures were at daily highs (Osmond et al. 2007). It is important to consider that this daily cycle of activity may vary at different times of the year. Bond et al. (2012) observed that cattle spent more time in waterways during summer and that there was a difference in the use of riparian areas between the months of Autumn and Spring, concluding that there was a positive correlation between air temperature and the amount of time cattle spent in waterways. It is during summer and autumn, when water flows are low, that water quality impact increases. Therefore, it is important that to undertake further research to collect animal data movement around hill country streams and wet areas during these critical risk periods.

It is not clear why the time individual cows spend in streams and wet areas varies. Existing literature suggests that animals may develop preference or aversion to riparian areas via social or learned behaviour (Osmond e al. 2007; Bond et al. 2012). It is also possible that cattle breed and genetics can influence the amount of time cattle spend in waterways and this aspect appears to require further research.

Conclusions

This study provides insight in to the amount of time cattle spend in and around streams and wet areas in a NZ hill country farm. The results indicate that cattle, with unrestricted access, spend over 1 hr/day in streams and wet areas in winter months. Cattle spent more time in and around streams and wet areas during the afternoon. Future studies should evaluate the seasonal differences on the amount of time cattle spend in and around streams and wet areas.

Acknowledgements

Financial support was provided by Beef + Lamb New Zealand.

References

Bond TA, Sear D, Edwards M 2012. Temperature-driven river utilisation and preferential defecation by cattle in an English chalk stream. Livestock Science 14: 659–66.

Draganova I 2012. Nutrient distribution and behaviour of livestock in an intensively managed dairy herd: a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy. Massey University, Palmerston North, New Zealand.

Franklin D, Cabrera M, Byers H, Matthews M, Andrae J, Radcliffe D, Calvert V 2014. Impact of water troughs on cattle use of riparian zones in the Georgia Piedmont in the United States. Journal of Animal Science 87(6): 2151–2159.

Fransen P, Burkitt L, Bretherton M, Horne D, Singh R, Hickson R, Morris S 2017. Selection of cattle supplement feeding areas to reduce nutrient and sediment loss in surface runoff from hill country. In: Science and policy: nutrient management challenges for the next generation. (Currie LD, Hedley MJ eds.). Occasional Report No. 30. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

McKergow LA, Matheson FE, Quinn JM 2016. Riparian management: A restoration tool for New Zealand streams. Ecological Management & Restoration (3): 218–227.

Ministry for the Environment 2016. Next steps for fresh water: Consultation document. Wellington: Ministry for the Environment, New Zealand.

Osmond DL, Butler DM, Ranells NN, Poore MH, Wossink A, Green JT 2007. Grazing practices: a review of the literature. North Carolina Agricultural Research Service, Technical Bulletin 325-W. North Carolina State University. Raleigh, NC, USA.